



# AEROSPACE MATERIAL

Society of Automotive Engineers, Inc.  
TWO PENNSYLVANIA PLAZA, NEW YORK, N. Y. 10001

## SPECIFICATION

# AMS 6305

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Revised

STEEL BARS, FORGINGS, AND TUBING, LOW-ALLOY, HEAT-RESISTANT  
0.95Cr - 0.55Mo - 0.30V (0.40 - 0.50C)  
Vacuum Arc Remelted

### 1. SCOPE:

1.1 Form: This specification covers a premium quality, low-alloy, heat-resistant steel in the form of bars, forgings, mechanical tubing, and stock for forging or heading.

1.2 Application: Primarily for parts such as compressor discs, turbine discs, shafts, and fasteners subjected to temperatures up to 1000° F (538° C) and subject to very rigid inspection standards.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Materials Specifications (AMS) and Aerospace Standards (AS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, New York 10001.

#### 2.1.1 Aerospace Material Specifications:

AMS 2251 - Tolerances, Alloy Steel Bars  
AMS 2253 - Tolerances, Carbon and Alloy Steel Tubing  
AMS 2259 - Chemical Check Analysis Limits, Wrought Low Alloy and Carbon Steels  
AMS 2300 - Premium Aircraft Quality Steel Cleanliness, Magnetic Particle Inspection Procedure  
AMS 2350 - Standards and Test Methods  
AMS 2370 - Quality Assurance Sampling of Carbon and Low Alloy Steels, Wrought Products Except Forgings  
AMS 2372 - Quality Assurance Sampling of Carbon and Low Alloy Steels, Forgings and Forging Stock  
AMS 2375 - Approval and Control of Critical Forgings  
AMS 2808 - Identification, Forgings

#### 2.1.2 Aerospace Standards:

AS 1182 - Standard Machining Allowance, Aircraft Quality and Premium Quality Steel Products

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

ASTM A370 - Mechanical Testing of Steel Products  
ASTM A604 - Macroetch Testing of Consumable Electrode Vacuum Arc Remelted Steel Bars and Billets  
ASTM E112 - Estimating Average Grain Size of Metals  
ASTM E350 - Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania, 19120.

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2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

3. TECHNICAL REQUIREMENTS:

- 3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E350, by spectographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other approved analytical methods:

	min	max
Carbon	0.40	0.50
Manganese	0.40	0.70
Silicon	0.20	0.35
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	0.80	1.10
Molybdenum	0.45	0.65
Vanadium	0.25	0.35
Nickel	--	0.25
Copper	--	0.35
Lead	--	0.001 (10 ppm)

- 3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2259, paragraph titled "Low Alloy Steels".

- 3.2 Condition: The product shall be supplied in the following condition; hardness and tensile strength shall be determined in accordance with ASTM A370:

3.2.1 Bars:

- 3.2.1.1 Bars 0.500 In. (12.70 mm) and Under in Diameter or Distance Between Parallel Sides: Cold finished having tensile strength not higher than 125,000 psi (862 MPa) or equivalent hardness.

- 3.2.1.2 Bars Over 0.500 In. (12.70 mm) in Diameter or Distance Between Parallel Sides: Hot finished having hardness not higher than 229 HB or equivalent except that bars ordered cold finished may have hardness as high as 248 HB or equivalent.

- 3.2.2 Forgings: Annealed having hardness not higher than 248 HB or equivalent.

- 3.2.3 Mechanical Tubing: Cold finished having hardness not higher than 25 HRC or equivalent except that tubing ordered hot finished shall have hardness not higher than 99 HRB or equivalent.

- 3.2.4 Stock for Forging or Heading: As ordered by the forging or heading manufacturer.

- 3.3 Properties: The product shall conform to the following requirements; hardness testing shall be performed in accordance with ASTM A370:

- 3.3.1 Response to Heat Treatment: Test specimens, heated to 1750° F  $\pm$  25° (954.4° C  $\pm$  14°), held at heat for 60 - 90 min., and cooled in still air, reheated to 1100° F  $\pm$  15° (593.3° C  $\pm$  5.6°), held at heat for 6 hr  $\pm$  15 min., and cooled in air shall have hardness at the center of the test specimen not lower than 331 HB or equivalent for sections 2 in. (51 mm) and under and not lower than 302 HB or equivalent for 4 in. (102 mm) section thicknesses.

- 3.3.2 Grain Size: Predominantly 5 or finer with occasional grains as large as 3 permissible, ASTM E112, McQuaid-Ehn test.

3.3.3 Macrostructure: Visual examination of transverse sections from bars, billets, forging stock, and tube rounds, etched in accordance with ASTM A604 in hot hydrochloric acid (1:1) at 160 - 180 F (71.1 - 82.2 C) for sufficient time to develop a well-defined macrostructure, shall show no injurious imperfections such as pipe, cracks, porosity, segregation, and inclusions detrimental to fabrication or to performance of parts. Macrostructure shall be equal to or better than the following macrographs of ASTM A604:

Class	Condition	Severity
1	Freckles	B
2	White Spots	C
3	Radial Segregation	C
4	Ring Pattern	As agreed upon

3.3.4 Decarburization:

- 3.3.4.1 Bars and tubing ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces. Decarburization on tubing ID shall not exceed the maximum depth specified in Table II.
- 3.3.4.2 Allowable decarburization of bars, billets, and tube rounds ordered for redrawing or forging or to specified microstructural requirements shall be as agreed upon by purchaser and vendor.
- 3.3.4.3 Decarburization of bars to which 3.3.4.1 or 3.3.4.2 is not applicable shall be not greater than shown in Table I:

TABLE I

Nominal Diameter or Distance Between Parallel Sides Inches	Depth of Decarburization Inch
Up to 0.375, incl	0.015
Over 0.375 to 0.500, incl	0.017
Over 0.500 to 0.625, incl	0.019
Over 0.625 to 1.000, incl	0.022
Over 1.000 to 1.500, incl	0.025
Over 1.500 to 2.000, incl	0.030
Over 2.000 to 2.500, incl	0.035
Over 2.500 to 3.000, incl	0.040
Over 3.000 to 4.000, incl	0.045

TABLE I (SI)

Nominal Diameter or Distance Between Parallel Sides Millimeters	Depth of Decarburization Millimeters
Up to 9.52, incl	0.38
Over 9.52 to 12.70, incl	0.43
Over 12.70 to 15.88, incl	0.48
Over 15.88 to 25.40, incl	0.56
Over 25.40 to 38.10, incl	0.64
Over 38.10 to 50.80, incl	0.76
Over 50.80 to 63.50, incl	0.89
Over 63.50 to 76.20, incl	1.02
Over 76.20 to 101.60, incl	1.14

- 3.3.4.3.1 Limits for depth of decarburization of bars over 4.000 in. (101.60 mm) in nominal diameter or distance between parallel sides shall be as agreed upon by purchaser and vendor.
- 3.3.4.4 Decarburization of tubing to which 3.3.4.1 or 3.3.4.2 is not applicable shall be no greater than shown in Table II:

TABLE II

Nominal Wall Thickness Inches	Depth of Decarburization Inch	
	ID	OD
Up to 0.109, incl	0.008	0.020
Over 0.109 to 0.203, incl	0.010	0.025
Over 0.203 to 0.400, incl	0.012	0.030
Over 0.400 to 0.600, incl	0.015	0.035
Over 0.600 to 1.000, incl	0.017	0.040
Over 1.000	0.020	0.045

TABLE II (SI)

Nominal Wall Thickness Millimeters	Depth of Decarburization Millimeters	
	ID	OD
Up to 2.77, incl	0.20	0.51
Over 2.77 to 5.16, incl	0.25	0.64
Over 5.16 to 10.16, incl	0.30	0.76
Over 10.16 to 15.24, incl	0.38	0.89
Over 15.24 to 25.40, incl	0.43	1.02
Over 25.40	0.51	1.14

- 3.3.4.5 Decarburization shall be measured by the microscopic method or by Rockwell Superficial 30-N scale or equivalent hardness testing method on hardened but untempered specimens protected during heat treatment to prevent changes in surface carbon content. Depth of decarburization, when measured by a hardness method, is defined as the perpendicular distance from the surface to the depth under that surface below which there is no further increase in hardness. Such measurements shall be far enough away from any adjacent surface to be uninfluenced by any decarburization or lack of decarburization thereon.
- 3.3.4.5.1 When determining the depth of decarburization, it is permissible to disregard local areas provided the decarburization of such areas does not exceed the above limits by more than 0.005 in. (0.13 mm) and the width is 0.065 in. (1.65 mm) or less.
- 3.4 **Quality:** Steel shall be premium quality conforming to AMS 2300. The product shall be uniform in quality and condition, clean, sound, and free from foreign materials and from internal and external imperfections detrimental to fabrication or to performance of parts.
- 3.4.1 Bars and tubing ordered ground, turned, or polished shall be free from seams, laps, tears, and cracks open to the ground, turned, or polished surfaces.
- 3.4.2 Product ordered to surface conditions other than ground, turned, or polished shall, after removal of the standard machining allowance, be free from seams, laps, tears, cracks, and other defects exposed to the machined surfaces. Standard machining allowance shall be in accordance with AS 1182.
- 3.5 **Sizes:** Except when exact lengths or multiples of exact lengths are ordered, bars and tubing will be acceptable in mill lengths of 6 - 20 ft (1.8 - 6.1 m) but not more than 10% of any shipment shall be supplied in lengths shorter than 10 ft (3 m).